

evidence now deduced as to a connexion of some sort between the behaviour of sun-spots and the positions of the planets Venus and Mercury. We think, however, it must be allowed, that the investigation is one of interest and importance, and we trust that arrangements may be made for the systematic continuance of solar observations in such localities as will ensure to us a daily picture of the sun's disk.

The influence of blank days in diminishing the value of a series of sun-observations is very manifest. We have been able to record the behaviour across the sun's disk of 421 groups of Carrington's series out of a total number of 885 groups, and we have been able to record the same behaviour for 373 out of 544 groups observed at Kew. Thus, out of a total of 1429 groups, we have only been able to record the behaviour of 794. Nor are the records which we have obtained so perfect as we could wish, on account of blank days, which make interpolations necessary. It is therefore of much importance for the future of such researches as the present, that there should be several observing-stations so placed that we may reckon on having at least a daily picture of the sun's disk.

It will be easily seen that such observations are very different from experiments, which may be multiplied *ad libitum*; for in this case Nature gives us in a year or in ten years a certain amount of information, and no more, while it depends upon ourselves to make a good use of the information which she affords.

It is already universally acknowledged that we ought to make the best possible use of the few precious moments of a total eclipse; but such observations must necessarily be incomplete unless they are followed up by the equally important, if more laborious, task of recording the sun's surface from day to day.

III. "The Decomposition of Water by Zinc in conjunction with a more Negative Metal." By J. H. GLADSTONE, Ph.D., F.R.S., and ALFRED TRIBE, F.C.S. Received February 8, 1872.

Pure zinc is incapable of decomposing pure water, even at 100° C., but at a considerably higher temperature it is known to combine with its oxygen. Davy exposed pure water for two days to the action of a pile of silver and zinc plates, separated only by pasteboard, without obtaining any hydrogen; Buff, however, has shown that a very minute trace of gas can be formed at the ordinary temperature by a pair of zinc and platinum plates.

During a series of experiments, of which we have already published an instalment, it occurred to us to ascertain whether by bringing the two metals closer together, and so increasing the electrical tension of the liquid, we could effect the same combination of zinc with oxygen at the ordinary temperature which takes place without the second metal at a very high

temperature. Thin sheets of zinc and copper were hammered together and placed in a bottle filled with distilled water. Small bubbles of gas were formed. The experiment, however, was tried in a more perfect form. Some zinc-foil was allowed to remain in a somewhat dilute solution of copper sulphate until its surface was well covered with spongy copper. The metals were thoroughly washed with distilled water, and then they were immersed in a bottle of distilled water with a delivery-tube. Minute bubbles of gas quickly made their appearance, which proved to be hydrogen, and zinc-oxide was formed. Two experiments were made quantitatively, the gas being collected and measured at the end of 24 or 48 hours. The quantity of gas in cubic centimetres is given in the third and fourth columns of the subjoined Table, corrected for temperature and pressure. The mean temperature in the second column is simply the mean of the maximum and minimum during the period. In experiment A, 33·4 grms. of zinc-foil were employed, being 2·6 metres long and 0·05 wide. The coils were kept apart by muslin. In experiment B there was used 1 metre of similar foil crumpled up.

Day.	Mean temp.	Exper. A.	Exper. B.	Day.	Mean temp.	Exper. A.	Exper. B.
	C.	c. c.	c. c.		C.	c. c.	c. c.
1.	12·8°	117·1	49·6	18.	6·7°	20·0	7·6
2.	12·2	93·8	37·5	19, 20.	6·1	17·2 (×2)	5·7 (×2)
3.	11·7	73·8	27·6	21.	4·4	20·0	6·6
4.	11·1	66·2	24·7	22.	5·0	15·3	4·8
5, 6.	10·0	49·3 (×2)	17·5 (×2)	Interval.			
7.	8·9	41·1	14·9	44.	10·0	20·5	5·5
8.	10·5	40·9	15·8	45, 46.	10·5	22·5 (×2)	6·5 (×2)
9.	10·0	40·9	14·8	47.	11·1	22·3	6·5
10.	7·8	33·8	10·3	48.	11·1	24·1	8·1
11.	6·7	28·0	9·4	49.	11·1	20·5	7·4
12, 13.	6·1	21·9 (×2)	7·7 (×2)	Interval.			
14.	6·1	20·1	7·6	82.	10·0	18·0	4·7
15.	7·2	31·1	10·3	83.	10·0	18·9	6·1
16.	10·0	30·0	10·2	84.	10·0	14·0	5·1
17.	8·3	29·4	8·5				

The two experiments have evidently gone on almost *pari passu* for months, the amount of hydrogen evolved gradually diminishing, but showing, at the same time, a certain dependence on the heat of the day.

Under the microscope the bubbles of gas are seen to form, not on the zinc, but among the copper crystals, and sometimes to make their appearance on the glass at some distance off.

From the position of platinum in the electro-chemical series we anticipated that the effect would be still more marked with that metal in a spongy state on the zinc. It was deposited from the tetrachloride, and, of course, thoroughly washed. There was only 0·6 metre of foil, but the following quantities of hydrogen were obtained:—

Day.	Mean temp.	Vol. in cub. centims.
1.	11.7° C.	143.6
2.	11.4	93.6
3, 4.	10.0	38.8 (×2)
5.	8.6	26.0
6.	10.8	21.0
7.	9.4	17.1
8.	7.7	12.3

The first action, therefore, was about five times as great as in the case of the copper, and it diminished more rapidly, doubtless through the zinc becoming more quickly protected by oxide.

Lest it might be contended that the free oxygen, usually present in distilled water, had been the means of starting this action, the experiment was repeated with water as free from oxygen as could be obtained by boiling. One metre of the same zinc-foil, covered with copper, was employed, and the result was nearly as before, 40 cub. centims. of gas being obtained the first day at the mean temperature of 9° C. This arrangement was taken advantage of to examine the effect of a high temperature. Without removing the delivery-tube, the contents of the flask were heated to near 100° C., when 123.5 cub. centims. of hydrogen were given off in ten minutes. The apparatus was allowed to cool, with the mouth of the tube under water, when the production of gas became small again, and after two days it was again heated nearly to the boiling-point, when it gave off 93.4 cub. centims. in ten minutes; after another period of two days it gave 64.1 cub. centims. and after three days more 132.1 cub. centims. in the first thirty minutes, 108.4 in the second thirty minutes, 94.3 in the third, and 89.9 in the fourth.

Iron and lead, under similar circumstances, also decomposed pure water, and the action of magnesium was greatly increased by conjunction with copper. The effect of the more negative metal was the same as would have been produced by an increase of heat.

In a practical point of view this experiment may serve as a ready means of preparing pure hydrogen; in a theoretical point of view, its interest seems to lie in the fact that the dissociation of a binary compound by means of two metals may take place at infinitesimally short distances, when it would not take place where the layer of liquid is enough to offer resistance to the current, and also in the correlation between this force and heat*.

P.S. March 14.—At the suggestion of Prof. Stokes, we tried to ascertain if the well-known influence of points had much to do with the separation of this hydrogen gas. Two thin plates of copper were taken, the one

* Since the above was written we have accidentally heard that Dr. W. Russell has been working in the same direction.

smooth, the other rough with electrolytically-deposited copper; these were separated from thin plates of zinc merely by pieces of muslin, and the metals were folded over at each end and hammered together. Each couple was placed in water, and for some days very minute bubbles of gas formed, but only at the junction of the metals, and about equally in each case.

As might be expected, this zinc in conjunction with copper is capable of decomposing other liquids than water. Chloroform yields readily to its power, and iodide of ethyl, which Prof. Frankland decomposed by zinc only at a great heat, is split up rapidly at the ordinary temperature.

March 21, 1872.

WILLIAM SPOTTISWOODE, M.A., Treasurer and Vice-President,
in the Chair.

The following communications were read:—

- I. “New Researches on the Phosphorus Bases.” By A. W. HOFMANN, LL.D., F.R.S., Professor of Chemistry in the University of Berlin. Received March 6, 1872.

About twelve years have elapsed since I submitted to the Royal Society, partly in conjunction with M. Cahours, a series of papers* on the remarkable group of phosphorus compounds, the existence of which was first pointed out by M. Paul Thenard as far back as 1846. These researches were devoted to the investigation of the *tertiary* and *quartary* derivatives of phosphoretted hydrogen, exclusively accessible by the methods then at our disposal. The study of the *primary* and *secondary* phosphines, the examination of which promised even more noteworthy results than that of the bodies then investigated, still remained to be achieved.

New tasks of life have since that time presented themselves, and I have not been able to devote myself as much to research as in former days. Nevertheless, numerous attempts were made to procure the primary and secondary phosphines, which were clearly indicated by theory and partly even by M. Thenard's early observations. For a long time, however, these experiments proved unsuccessful, and it was only in the course of last summer that I at last discovered an easy method for their production. I may now fairly hope to complete an inquiry, the first part of which the Royal Society have done me the honour of inserting in the ‘Philosophical Transactions’†; still some time will be required for surveying a field which appears to expand as one advances in its investigation, and I therefore beg leave to present to the Society the results of my observations in the measure as they are obtained, even before the whole investigation be terminated.

* Proceedings, vol. viii. pp. 500, 523; vol. ix. pp. 287, 290, 487, 651; vol. x. pp. 100, 189, 603, 608, 610, 613, 619; vol. xi. pp. 286, 290.

† Phil. Trans. 1857, p. 575; 1860, pp. 409, 449, 497.